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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/753,393	01/09/2004	Takashi Udagawa	Q79052	7899

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EXAMINER	
MONDT, JOHANNES P	

ART UNIT	PAPER NUMBER
3663	

DATE MAILED: 01/20/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/753,393	UDAGAWA, TAKASHI	
	Examiner	Art Unit	
	Johannes P. Mondt	3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *22-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *22,28 and 30* is/are allowed.

6)☒ Claim(s) *23-27,29 and 31-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Amendment filed 11/18/2005 forms the basis for this office action. In said Amendment Applicant substantially amended claims 23-27, 29 and 31-34 through substantial amendments of independent claims 23 and 29. Applicant also added new claims 33 and 34. Comments on Remarks submitted with said Amendment are included below under "Response to Arguments".

Claim Rejections - 35 USC § 112

The following is a quotation of the fourth paragraph of 35 U.S.C. 112:

> Subject to the following paragraph, a claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers

1. ***Claim 32*** is rejected under 35 U.S.C. 112, fourth paragraph.

According to 35 U.S.C. 112, fourth paragraph, a claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. However, dependent ***claim 32*** in the dependency on claim 23 fails to do so: it only contains the limitation {"wherein the $GaN_{1-x}P_x$ lower clad layer is a single crystal layer"} already materially and integrally contained in dependent claim 23.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

1. ***Claims 23-27, 29 and 31-34*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Terashima et al (6,069,021) (see Information Disclosure Statement filed 01/09/2004) in view of Ishida et al (6,339,014 B1) and Yoshida (JP 11171699 A).

<u>On claims 23 and 32</u>: *Terashima et al teach* a group-III nitride semiconductor light-emitting device (cf. title, abstract and col. 1) comprising (cf. Example 3, Figure 2) a single crystal substrate 101 (cf. col. 5, l. 6-22 and col. 13, l. 59-65), a boron phosphide (BP)-based buffer layer 110 (cf. col. 14, l. 51-60) and a double hetero-junction light-emitting part structure containing a $GaN_{1-x}As_x$ lower clad layer 104 ($0<x<1$) (loc.cit.); N.B.: layer 104 is a GaN layer doped with As, which is a $GaN_{1-x}As_x$ layer*), the As compositional ratio (x) of the $GaN_{1-x}As_x$ lower clad layer is set to obtain the lattice matching with the BP-based buffer layer* (col. 7, l. 60 – col. 8, l. 3),a $Ga_\gamma In_{1-\gamma}N$ ($0 \leq Y \leq 1$) light-emitting layer 105 (cf. col. 14, l. 65-col. 15, l. 3) with Y in the range $0.9 \leq Y \leq 1$, specifically y=0.98 (col. 14, l. 66) and an $Al_zGa_{1-z}N$ ($0<= z <= 1$) upper clad layer 106 (cf. col. 15, l. 4-12; N.B. the parameter range for z as claimed includes the point z=0) having a conduction type (p-type) (cf. loc.cit.) opposite to that of the lower clad layer (which has n-type conductivity, see col. 14, l. 52).

Terashima et al do not necessarily teach the lower clad layer to be a $GaN_{1-x}P_x$ lower clad layer instead of a $GaN_{1-x}As_x$ lower clad layer, because Terashima et al teach doping the GaN layer 104 with As. *However, it would have been obvious* to use P

instead of As for doping in view of Ishida et al, who, in a patent on a method for growing nitride compound semiconductors (cf. title and abstract), hence closely related to Terashima et al, teach at least the equivalence of using P rather than As for the growing of n-type GaN layers (cf. col. 6, l. 62 – col. 7, l. 15); given the use of P-doping in a prior step in Terashima et al, namely in the formation of the buffer layer (cf. col. 13, l. 59-65 in Terashima et al) it would have been obvious to use the same dopant thus obviating the need for additional complexity in the manufacturing process, while the lattice matching achieved by selecting As as taught by Terashima et al and selecting x could have been equally straightforwardly achieved through doping with P (phosphorous): in particular, the exploitation of the doping for the specific purpose of lattice matching can be equally achieved through the selection of P instead of As at the same stoichiometric ratio of x=0.01, considering that the lattice constant of $GaN_{1-x}P_x$ for x=0.01 (4.519 A) is just as much substantially the same as the lattice constant of 4.520 A of the surface portion of the buffer layer 110 above it (cf. Figure 2) as the lattice constant of $GaN_{1-x}As_x$ for the same value of x (i.e., 4.521 A) (cf. col. 14, l. 52-60). It is noted that "lattice matching" and "excellent" "lattice matching" in the context of the Specification mean lattice-matching within 1% and 0.4%, respectively (see Specification, page 16), which is amply met be Terashima et al: the lattice matching achieved by Terashima et al is 0.002/4 = 0.0005 or 0.05%. Thus, the statement of "zero" lattice matching" in the Specification on page 21 must be read within the context of the standard deviations indicated in the Specification as discussed above.

Motivation to replace As with P in this regard derives at least from the economic saving of using the P source already in use for the process of making the buffer layer in the device by Terashima (cf. col. 13, l. l. 53-65) instead of having to use the As source (cf. col. 14, l. 43-50), and in addition from the obvious toxic nature of As.

Neither Terashima et al nor Ishida et al necessarily teach the entire lower clad layer to be a single crystal clad layer as a mixed crystal of gallium nitride (GaN) and gallium phosphide (GaP).

However, it would have been obvious to include the limitation that said lower clad layer is a single crystal lower cladding layer as a mixed crystal of gallium nitride (GaN) and gallium phosphide (GaP) in view of Yoshida, who, in a patent document on a method of crystal growing teaches how the achieve a gallium nitride phosphide crystal as a single crystal starting as a mixture of gallium, nitrogen and phosphorous (see English abstract). Because the crystallization takes place in a three-component mixture and nitrogen and phosphorous do not bond the mixture necessarily contains both GaN and GaP bonds, i.e., GaN and GaP. Also, applicant is reminded that the single crystal only is patentable as final structure, not by how it is made, because only the device and not its method of making has been claimed. Furthermore, in view of the stated goal by Terashima et al to achieve a lower clad layer of excellent crystallinity (see columns 1 and 2, "Background of the Invention" and col. 11, l. 53-65) it would have been obvious to include the teaching by Yoshida in the combined invention by Terashima et al and Ishida et al in order to further improve the excellence of said crystallinity of said lower cladding layer, which provides ample *motivation* because crystal imperfections are traps

for charge carriers that otherwise partake in creating light through the basic mechanism of electron-hole recombination, which is behind the motivation for lattice matching as admitted by Applicant in the specification (see M. Fukuda page 93 on basic mechanism of light-emitting diodes, just as information, not as reference; and similarly see Applicant's specification, "Background of the Invention", on page 2, lines 10-20).

Finally, *claim 32*, in its dependence upon claim 23, fails to further distinguish over the prior art because the further limitation defined by claim 32 had already been recited fully in claim 23 (see rejection under 35 U.S.C. 112, fourth paragraph overleaf).

On claim 24: the further limitation on the invention as now claimed by substantially amended claim 23, claiming a range for the dislocation density of a lattice-matched lower clad layer, is not disclosed in the Specification other than being achieved through the reduction of lattice mismatch to levels defined in the Specification to amount to lattice matching (i.e., less than 1% and preferentially less than 0.4%; see page 16 of the Specification and final paragraph of the "Summary of the Invention" and page 29, first full paragraph). Because said reduction of lattice mismatch is equally if not better achieved by the prior art as discussed above (claim 23) Applicant in the Specification does not disclose a different range for said dislocation density than as found in the prior art.

On claim 25: the light emitting layer105 by Terashima has the same lattice constant of 4.51 A as does the upper surface of the second buffer layer 104 (for x=0.12 and Vegard's Law applied to GaInN for x=0.12). Because said second buffer layer lattice matches to said lower clad layer it follows that the light emitting layer lattice

matches to said lower clad layer, and hence the combined invention by Terashima et al in view of Ishida et al meets the further limitation as defined by claim 25. In this regard please note that Ishida et al only needs to teach a different material constitution of the lower clad layer but without any modification to its lattice constant (see discussion of claim 23 above).

On claim 26: because the same lattice matching procedure is successfully applied in the prior art as is in the invention and because Applicant discloses the claimed range for the dislocation density only to be due to said lattice matching the further limitation as defined by claim 26 does not further distinguish over the prior art either. Please note that in both the invention and in Terashima the production method of the light-emitting layer is MOCVD (Terashima et al, col. 9, l. 38-46 and page 28 of the Specification).

On claim 27: the buffer layer has a lattice constant (4.52 A) of the original crystal of the material on the buffer layer surface opposite the junction interface with the substrate (i.e., opposite the surface that forms part of said junction interface), because the upper surface of the buffer layer is part of the buffer layer. Furthermore, the thickness of the buffer layer is 200 A (col. 14, 39), i.e., 20 nm which is in the range of 5 nm to 50 nm as claimed. Parenthetically, the limitation "original" does not carry any patentable weight, the final structure being the subject of the present invention. To amplify, in reference to the claim language referring to "original", intended use and other types of functional language must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from

the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In re Casey,152 USPQ 235 (CCPA 1967); In re Otto , 136 USPQ 458, 459 (CCPA 1963).

On claims 29 and 31: Terashima et al teach a group-III nitride semiconductor light-emitting device (cf. title, abstract and col. 1) comprising (cf. Example 3) a single crystal substrate 101 (cf. col. 5, l. 6-22 and col. 13, l. 59-65), a boron phosphide (BP)-based buffer layer 110 (cf. col. 14, l. 51-60) and a double hetero-junction light-emitting part structure containing a $GaN_{1-x}As_x$ lower clad layer 104 ($0<x<1$) (cf. col. 14, l. 52-60; N.B.: layer 104 is a GaN layer doped with As, which is a $GaN_{1-x}As_x$ layer*), the As compositional ratio (x) of the $GaN_{1-x}As_x$ lower clad layer is set to obtain the lattice matching with the BP-based buffer layer* (col. 7, l. 60 – col. 8, l. 3),a $Ga_\gamma In_{1-\gamma}N$ ($0 \leq Y \leq 1$) light-emitting layer 105 (cf. col. 14, l. 65-col. 15, l. 3) with Y within the range $0.9 \leqq Y \leqq 1$, specifically Y= 0.98, and an $Al_zGa_{1-z}N$ ($0 \leq z \leq 1$) upper clad layer 106 (cf. col. 15, l. 4-12; N.B. the parameter range for z as claimed includes the point z=0) having a conduction type (p-type) (cf. loc.cit.) opposite to that of the lower clad layer (which has n-type conductivity, see col. 14, l. 52). The lattice mismatch between the BP-based buffer layer and the GaN1-xAsx lower clad layer by Terashima et al is 0.05% as discussed above in the rejection of claim 23, and again below in connection with the obviousness to include the teaching by Ishida et al, meets the limitation on lattice mismatch bounds of both claims 29 and 31.

Terashima et al do not necessarily teach the lower clad layer to be a $GaN_{1-x}P_x$ lower clad layer instead of a $GaN_{1-x}As_x$ lower clad layer, because Terashima et al teach

doping the GaN layer 104 with As while yet meeting the requirement of lattice matching to within a lattice mismatch of 1 %. *However, it would have been obvious* to use P instead of As for doping in view of Ishida et al, who, in a patent on a method for growing nitride compound semiconductors (cf. title and abstract), hence closely related to Terashima et al, teach at least the equivalence of using P rather than As for the growing of n-type GaN layers (cf. col. 6, l. 62 – col. 7, l. 15); given the use of P-doping in a prior step in Terashima et al, namely in the formation of the buffer layer (cf. col. 13, l. 59-65 in Terashima et al) it would have been obvious to use the same dopant thus obviating the need for additional complexity in the manufacturing process, while the lattice matching achieved by selecting As as taught by Terashima et al could have been equally straightforwardly achieved through doping with P (phosphorous): in particular, the exploitation of the doping for the specific purpose of lattice matching can be equally achieved through the selection of P instead of As at the same stoichiometric ratio of x=0.01, considering that the lattice constant of $GaN_{1-x}P_x$ for x=0.01 (4.519 A) is just as much substantially the same as the lattice constant of 4.520 A of the surface portion of the buffer layer 110 above it (cf. Figure 2) as the lattice constant of $GaN_{1-x}As_x$ for the same value of x (i.e., 4.521 A) (cf. col. 14, l. 52-60). It is noted that "lattice matching" and "excellent" "lattice matching" in the context of the Specification mean lattice-matching within 1% and 0.4%, respectively (see Specification, page 16), which is amply met be Terashima et al: the lattice matching achieved by Terashima et al is 0.002/4 = 0.0005 or 0.05%. Thus, the statement of "zero" lattice matching" in the Specification on

page 21 must be read within the context of the standard deviations indicated in the Specification as discussed above.

Motivation to replace As with P in this regard derives at least from the economic saving of using the P source already in use for the process of making the buffer layer in the device by Terashima (cf. col. 13, l. l. 53-65) instead of having to use the As source (cf. col. 14, l. 43-50), and in addition from the obvious toxic nature of arsenic (As).

Neither Terashima et al nor Ishida et al necessarily teach the entire lower clad layer to be a single crystal clad layer as a mixed crystal of gallium nitride (GaN) and gallium phosphide (GaP).

However, it would have been obvious to include the limitation that said lower clad layer is a single crystal lower cladding layer as a mixed crystal of gallium nitride (GaN) and gallium phosphide (GaP) in view of Yoshida, who, in a patent document on a method of crystal growing teaches how the achieve a gallium nitride phosphide crystal as a single crystal starting as a mixture of gallium, nitrogen and phosphorous (see English abstract). Because the crystallization takes place in a three-component mixture and nitrogen and phosphorous do not bond the mixture necessarily contains both GaN and GaP bonds, i.e., GaN and GaP. Also, applicant is reminded that the single crystal only is patentable as final structure, not by how it is made, because only the device and not its method of making has been claimed. Furthermore, in view of the stated goal by Terashima et al to achieve a lower clad layer of excellent crystallinity (see columns 1 and 2, "Background of the Invention" and col. 11, l. 53-65) it would have been obvious to include the teaching by Yoshida in the combined invention by Terashima et al and

Ishida et al in order to further improve the excellence of said crystallinity of said lower cladding layer, which provides ample *motivation* because crystal imperfections are traps for charge carriers that otherwise partake in creating light through the basic mechanism of electron-hole recombination, which is behind the motivation for lattice matching as admitted by Applicant in the specification (see M. Fukuda page 93 on basic mechanism of light-emitting diodes, just as information, not as reference; and similarly see Applicant's specification, "Background of the Invention", on page 2, lines 10-20).

On claims 33-34: the selection of the (stoichiometric) composition of the BNP buffer layer is determined by the lattice matching condition, giving the composition of the lower clad layer. Given the lattice constants of BN (3.6157 Å), BP (4.5383 Å), GaN and GaP (4.51 Å and 4.538 Å, respectively) and Vegard's Law (see Fukuda, page 7) this only requires judicious choice of the stoichiometric ratio in $BN_{1-\xi}P_{\xi}$ to meet the claim limitation. For instance, for X=0.01 the lattice constant of the lower clad layer is equal to ξ=0.970, which only slightly differs from the value of 0.98 needed in Terashima et al (col. 14, l. 59). For the other ends of the range, i.e., X=0.05, the lattice constant of the lower clad layer is 4.5114 Å and is matched by x = 0.971. Evidently, the value X=0.03 (the lower limit of the range recited in claim 34) is in between the extremes of 0.970 and .971. It is thus seen that the claim limitation in the form of the claimed range for X is (a) a choice primarily determined within a wide range to allow lattice matching through inserting the BNP buffer layer, and (b) requiring only deviations within about 1% for the stoichiometric parameter of BNP at the interface from the values in Terashima et al. Such change is small and not necessarily disadvantageous, and does not deter in any

way from the advantages as noted above to include the teachings by Ishida et al and Yoshida.

Allowable Subject Matter

2. ***Claims 22, 28 and 30*** are allowed. The following is a statement of reasons for the indication of allowable subject matter: within the context of claim 22 or claim 28, i.e., group-III nitride semiconductor light-emitting device on a single crystal substrate with a buffer layer based on boron phosphide, *the single heterostructure as claimed, i.e., the single heterostructure consisting of a GaInN light emitting layer and a GaNP lower clad layer has not been found* in the prior art.

Response to Arguments

Applicant's arguments filed 11/18/2005 have been fully considered but on the whole they are not persuasive.

The claim rejection under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement has been overcome through the amendments to independent claims 23 and 29.

Arguments in traverse appear to rely exclusively on the claim language as amended.

Reading of Terashima et al (6,069,021) as cited for independent claims 23 and 29 reveals that since lower clad layer 104 is lattice matched with underlying buffer layer 103/110 so as to achieve "excellent crystallinity" of the lower clad layer 104. See column 11, lines 53-65 in Terashima et al. Lattice matching at the interface logically implies a

monocrystalline sub-layer abutting the interface with said buffer layer as otherwise there would be no lattice to match at the interface, crystal lattice being a three-dimensional property. At the very least, then, there is a *sub-layer* of a lower clad layer (104) that meets the limitation "single crystal lower clad layer", which, in the patent to Terashima et al is a mixed crystal of GaN and GaAs, as witnessed by the stoichiometric formula $GaN_{1-x}As_x$ (see office action and citations to the relevant portions in Terashima et al). Moreover, considering that the objective of Terashima et al evidently includes achieving a lower cladding layer 104 "of excellent crystallinity" (loc.cit.), said objective would be further enhanced if the (entire) lower cladding layer be made of a single crystal layer.

Motivation to replace said cladding layer with the cladding layer of the composition taught by Ishida et al (6,339,014 B1) as cited in conjunction with Terashima et al for said independent claims 23 and 29 is independent of the mono-crystallinity.

The only question that could be raised is whether $GaN_{1-x}P_x$ can be made as a mixed crystal of gallium nitride (GaN) and gallium phosphide (GaP). It is shown by patent document JP 11171699 A (Yoshida) to Furukawa Electric Co. Ltd of June 1999 (henceforth called "Yoshida") that a single crystal $GaN_{1-x}P_x$ layer can be made which is a mixture of GaN and GaP because ingredients N and P are mixed with Ga (see English abstract and front figure) thus inherently causing a mixed crystal. Furthermore, Applicant is reminded that any method of making limitation is not of patentable weight in the present application, which is directed, if only by original presentation, to a device. Any distinction of patentable weight must therefore be made based on structural differences.

It would have been obvious to include the teaching of Yoshida in the implementation of the teaching by Ishida et al to further the goal stated by Terashima et al to achieve "excellent crystallinity" for the lower cladding layer 104.

New claims 33-34 are herewith being considered for the first and earliest possible time.

The rejections overleaf are based on the above considerations.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack W. Keith can be reached on 571-272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JPM
January 16, 2006

JACK KEITH
SUPERVISORY PATENT EXAMINER